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Informal Regulation of Industrial Pollution in Developing Countries

Evidence from Indonesia

Sheoli Pargal
David Wheeler

The pollution intensity of emissions is much higher for plants located in poorer, less-educated communities than in richer, better educated ones. This difference appears to be too large to reflect preferences alone. Differential ability to pressure polluting firms may also be important.

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Summary findings

Pargal and Wheeler test a model of supply-demand relations in an implicit market for environmental services when formal regulation is absent.

They use plant-level data from Indonesia for 1989–90, before the advent of nationwide environmental regulation. Treating pollution as a derived demand for environmental services, their model relates emissions of biological oxygen demand to the price (expected cost) of pollution; to prices of other inputs (labor, energy, materials); and to enterprise characteristics that may affect pollution demand, including scale, vintage, ownership, and efficiency.

The price of pollution is determined by the intersection of plant-level demand and a local environmental supply function, enforced by community pressure or informal regulation. Environmental supply is affected by community income, education, the size of the exposed population, the local economic importance of the plant, and its visibility as a polluter.

Their results are strongly consistent with the existence of an informal "pollution equilibrium." Pollution intensity declines with increases in plant size, efficiency, and local materials prices. Older plants and publicly owned facilities are more pollution-intensive; multinational ownership has no independent effect.

The results also suggest that the price of pollution is higher when plants are particularly visible and is *far lower* in poorer, less-educated communities. Thus, the intensity of pollution is *far higher* in such communities.

While it would be premature to generalize from these results, they suggest that the model of optimal pollution control in environmental economics is more relevant for developing countries than many have believed. Community-factory interactions seem to reflect environmental supply-demand considerations even when formal regulation does not exist.

In addition, the apparent power of informal regulation implies that cost-effective formal systems should be designed to complement, not supplant, community control. In particular:

- Local communities should not be forced to rely so heavily on visibility when judging environmental performance. Formal regulation should include publication of audited emissions reports from factories.
- Environmental injustice may be real and important. Many poor, uneducated communities may need extra support from national regulators.
- However, appropriate regulation should strike the right balance between equity and efficiency. Uniform national standards go too far because they eliminate all the natural and legitimate regional diversity that is also reflected in informal arrangements.

This paper — a product of the Environment, Infrastructure, and Agriculture Division, Policy Research Department — is part of a larger effort in the department to understand variations in pollution across firms. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Elizabeth Schaper, room N10-037, extension 33457 (22 pages). February 1995.

INFORMAL REGULATION OF INDUSTRIAL POLLUTION IN DEVELOPING COUNTRIES: EVIDENCE FROM INDONESIA

by

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EXECUTIVE SUMMARY

This paper tests a model of supply-demand relations in the implicit market for environmental services when formal regulation is absent. We use plant-level data from Indonesia for the period 1989-90, before the advent of nationwide formal regulation. Treating pollution as a derived demand for environmental services, we develop an estimating equation which is like a conventionally-specified input demand function. The dependent variable is plant-level discharge of Biological Oxygen Demand, a major water pollutant. Righthand variables include the price (expected cost) of pollution; prices of other inputs (labor, energy, materials); and enterprise characteristics which may affect pollution demand, including scale, vintage, ownership, and efficiency.

In our model, the expected cost of pollution for factories can be positive without formal regulation because of pressure (or informal regulation) by neighboring communities. Community power and preferences are revealed in an environmental supply function - the schedule of penalties which the firm expects the community to impose as pollution increases. Equilibrium pollution is determined by the intersection of pollution demand and supply schedules at the factory level. The supply schedule is affected by community income, education, size of the exposed population, the local economic importance of the plant, and its visibility as a polluter. The latter variable clearly distinguishes formal from informal regulation; when regulators do not monitor and report emissions, communities must rely on visible signs of damaging activity.

Our econometric results are strongly consistent with the existence of an informal 'pollution equilibrium' in Indonesia before national regulation was instituted. The results suggest that:

- Water pollution intensity declines significantly with increases in plant size, efficiency and visibility to the local community.
- Production is significantly less pollution-intensive in areas where materials prices are high; results for wages and energy prices are in the same direction but much weaker.
- Older plants and publicly-owned facilities are more pollution intensive. Multinational ownership has no independent effect on pollution intensity.
- Pollution intensity is <u>far higher</u> in poorer, less-educated communities.

For the informal regulation hypothesis, the last result is particularly important: Ceteris paribus, plants in Indonesian kabupaten (municipalities) with 25th-percentile income and post-primary schooling are estimated to have water pollution intensity **15 times** the prevailing level in kabupaten with 75th-percentile income and education. An exploratory analysis of the data suggests that much of this disparity may be due to intercommunal differences in power, not preferences.

It would be premature to generalize from the results reported in this paper, since they are based on data for emissions of one water pollutant in one country. However, our findings are consistent with the following propositions:

- The model of optimal pollution control in environmental economics provides a more appropriate paradigm for developing countries than many have believed. Community-factory interactions seem to reflect environmental supply-demand considerations even when formal regulation does not exist.

- Policies which favor competition, privatization and elimination of input subsidies should significantly reduce the water pollution intensity of manufacturing.

- Rapid improvements in community income and education will probably significantly lower the water pollution intensity of manufacturing.

- The apparent power of informal regulation implies that cost-effective formal systems should be designed to complement, not supplant, community control. In particular:

    - Local communities shouldn't be forced to rely so heavily on visibility when judging environmental performance. Formal regulation should include publication of audited emissions reports from factories.

    - 'Environmental injustice' may be real and important. Many poor, uneducated communities may need extra support from national regulators.

    - However, appropriate regulation should strike the right balance between equity and efficiency. National uniform standards go too far because they eliminate all the natural and legitimate regional diversity which is also reflected in informal arrangements.

1. INTRODUCTION

Under formal regulation, the government acts as an agent for the community in controlling industrial pollution. In the absence of such an institutional agent, a conventional analysis would assume that pollution is costless and essentially unconstrained. However, a growing body of evidence from Asia and Latin America suggests that this is not the case. In developing countries where formal regulation is weak or absent, many communities appear to have struck bargains for pollution abatement with local factories. We term this phenomenon 'informal regulation': Acting in their own self-interest, communities pursue levels of environmental quality which are desirable and feasible under local conditions.

1.1 The economics of informal regulation

In broad outline, our model of informal regulation resembles the textbook model of optimal market-based regulation.[1] Communities have implicit property rights in the local environment, and are willing to make their environmental resources available to polluters - but at escalating prices (or penalties) as pollution damage rises. Factories find ways to reduce their demand for environmental resources as expected penalties increase. Equilibrium arrangements reflect both demand- and supply-side considerations.

However, our model differs from the standard model in its assumptions about monitoring, regulatory instruments and enforcement. Communities must often strike bargains with poor information about plant-level emissions and risks. Without recourse to legal enforcement of existing regulations (if any), they must rely on the leverage provided by social pressure on workers and managers; adverse publicity; the threat (or use) of violence; recourse to civil law; and pressure through politicians, local administrators or religious leaders.

1.2 Implications for environmental policy

A significant role for informal regulation would have several implications for environmental policy in developing countries. First, it would suggest that the model of optimal pollution control in environmental economics provides a more appropriate paradigm for developing countries than many have believed.

Second, widespread informal regulation in a developing country represents a promising foundation for decentralized regulatory policy. In the

[1] See Tietenberg (1992).

textbook paradigm of environmental economics, optimal pollution loads and charges should vary across communities because local conditions create different marginal benefit and cost schedules for abatement. We would expect this to be true of informal regulation as well. New formal regulatory systems may be able to build on such local arrangements rather than replacing them at unnecessarily high cost. The imposition of a national system of uniform standards might, in fact, create enough deviation from locally-optimal standards to reduce welfare in some communities.[2]

Third, and probably most important, community income and education may be very important determinants of informal regulatory outcomes. Communities with low levels of education and information may give inappropriately low weight to pollution simply because they are not aware of the consequences.[3] Factories which are large local employers may receive deferential treatment from poor communities, even if they are heavy polluters. Finally, communities whose citizens are mostly poor, poorly educated or members of marginalized minority groups may have little ability to use the available channels of informal regulation. Significance for these factors would establish a clear case of 'environmental injustice.' To compensate, formal regulation could be targeted particularly on pollution control problems of poor communities.

1.3 Indonesia: the test case

This paper tests the informal regulation hypothesis using Indonesian plant-level data from several surveys conducted in 1989 and 1990. Indonesia provides a good test case. It is large and highly varied, in both environmental and socioeconomic dimensions. Indonesian manufacturing has been growing rapidly; industrial pollution is clearly a problem and, until very

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[2] To illustrate, suppose that community A has almost no industry (or industrial water pollution) and is located next to a large, swiftly-flowing river which rapidly disperses pollutants. Community B is heavily industrialized and located on a shallow lake which is easily contaminated. Under informal regulation, B may impose much tougher penalties on newly-arrived polluters than A. But if national regulators impose uniform standards, factories will have no incentive to avoid B or move to A. In fact, agglomeration economies may well attract them to B. The result could be higher pollution in B than the community would have accepted under informal regulation, and much lower income/employment in A than the community would have desired.

It is also true, of course, that poor information and leverage under informal regulation might negate this result. With national enforcement of uniform regulation, conditions in both communities could be worse-than-optimal from the perspective of environmental economics, but better than the available optimum under informal regulation.

[3] It might be argued that poorly educated or uninformed communities would be more alarmist, with consequent assignment of too much weight to pollution. In developing countries, however, the opposite seems generally true. Uninformed communities have no basis for judging pollution impacts which are not visible and immediate. See Huq/Wheeler (1992) for some illustrative cases from Bangladesh.

recently, most areas have had little or no formal pollution control. Indonesia's data collection system is also one of the most efficient and comprehensive in the developing world, permitting the construction of the broad database which has been necessary for this exercise.

The paper is organized as follows. In Section 2, we describe our model of informal regulation. Section 3 specifies an appropriate regression equation and describes the data. The results and implications are reported in Section 4, with a summary and conclusions presented in Section 5.

2. INDUSTRIAL POLLUTION UNDER INFORMAL REGULATION

Our model of informal regulation follows convention in defining emissions as the use of 'environmental services' - an additional production factor in an augmented KLEM (Capital, Labor, Energy, Materials) framework. The implicit 'price' of pollution is the expected penalty or compensation exacted by the affected community. It is different from other input prices in two ways. First, it may be plant-specific. Optimizing communities may tolerate polluting factories when they provide a lot of jobs, local contracts or tax revenues. Conversely, they may pay particular attention to plants whose location makes them particularly easy to monitor (e.g., large, isolated facilities) or particularly damaging to the local environment (e.g. pulp mills immediately upstream from local fisheries or irrigated rice fields).

Secondly, the price of pollution is an expectation, not a certainty. Plants learn about expected penalties or compensation for damage by observing patterns of community monitoring, activism, and their effects on other factories. Subsequent abatement decisions reflect the attempt to minimize total costs, including the expected cost of polluting at different levels.

2.1 Environmental supply

Informal regulation reflects local factories' acceptance of the community's property right in the environment. Communities use their leverage to impose penalties (costs) on firms whose emissions are judged unacceptable. As factories use up more local environmental quality, affected communities will impose higher costs. From the viewpoint of industry, the result is an 'environmental supply schedule', which shifts inward as average community education levels and income increase. Field survey evidence from Southeast Asia suggests that this schedule will depend on several factors: the level of community organization, information, legal or political recourse, media coverage, NGO presence, the efficiency of existing formal regulation, and the opportunity cost of time.[4] Many of these factors are likely to be correlated with community income and education levels.

2.2 Environmental Demand

Faced with a community-determined environmental supply schedule, each plant adjusts pollution to the optimal point along its pollution demand schedule, derived from its cost minimization exercise.[5] Thus, potentially-significant determinants of the environmental demand schedule include:

• **Output**: The KLEM framework dictates use of gross output value as the appropriate measure for this study. Of course, we expect pollution load to grow with output, ceteris paribus. However, most empirical studies of relations between plant size and pollution abatement have suggested that scale economies in abatement are the general rule. Thus, we would expect the elasticity of pollution with respect to output to be significantly less than one.

• **Relative input prices:** Pollution seems likely to be complementary to material inputs, but its cross-price relationships with labor, capital and energy are not clearly signed.

> *Materials*-intensive production also tends to be pollution-intensive because the volume of waste residuals is greater. Thus, an increase in material prices will encourage substitution toward products or technologies which are less materials- and pollution-intensive.
>
> *Labor* has a much more complex potential relationship with pollution. Applied econometric work on KLEM models has often suggested that K/E and L/M are complements but that the pairs KE and LM are gross substitutes in production.[6] If these relations hold, an increase in labor price will lead to declines in the use of both labor and materials, with a decline in pollution associated with the latter. On the other hand, labor is also an input to pollution abatement. In this dimension, an increased wage should lead to reduced abatement and higher pollution. The ultimate sign of the relationship is therefore ambiguous, although our prior view was that the direct production effect (complementarity) would dominate.

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[4] See Huq/Wheeler (1992) and Hartman/Huq/Wheeler (1994) for evidence from Indonesia, Thailand, Bangladesh and India.

[5] This is analogous to a standard input demand function.

[6] See Christenson, et al. (1973).

Capital is not a consideration for this exercise, since we do not have reliable capital stock data. We do not know whether or not capital is complementary to pollution in production. Abatement equipment, however, is counted as an addition to the firm's capital stock, so we would assume that this would contribute to a positive relationship between the price of capital and pollution (emissions).

Energy price increases should have a positive impact on labor, materials (and therefore pollution) if energy is a gross substitute in production. Energy can also be an important input to abatement, with another positive cross-price effect on pollution. In the case of air pollution, this positive effect would be attenuated by the impact of an energy price increase on fuel combustion. The latter is a major contributor to industrial air emissions. Overall, we might expect the gross substitute relation to dominate for water pollution and the fuel combustion effect to produce overall complementarity for air pollution.

- **Sector**: Sectors such as wood pulping and steelmaking have the potential to generate much higher pollution per unit of output than apparel manufacturing or electronics assembly. Abatement itself requires factor inputs subject to diminishing returns. Cost-minimizing firms in pollution-intensive sectors will therefore have higher equilibrium emissions intensity, whatever the implicit price of pollution.

- **Vintage**: Indonesia is still a heavy importer of production equipment from regulated OECD economies, where pollution control has been increasingly embodied in new process technologies. In addition, installation of end-of-pipe abatement equipment during plant construction is cheaper than retrofitting. With rising public concern over pollution in the 1980's, we would expect this cost factor to dictate a stronger response from new factories. 'Green consciousness' in some industrial societies may also drive their internationally-oriented construction contractors to pressure Indonesian clients toward greater abatement. For all these reasons, we would expect newer plants to be cleaner.

- **Efficiency**: Well-managed firms should be more capable of responding to incentives for pollution control. They should also be more profitable, with more discretionary funds available to respond to demands for cleanup. Finally, such firms should generate fewer waste residuals per unit of output. We would therefore expect more efficient firms to be cleaner.

- **Ownership**: Almost all multinational firms in Indonesia are headquartered in richer, more regulated economies where 'green consumerism' is an important factor for market reputation. They also have relatively low-cost access to clean technologies developed for the firms' OECD plants. Multinationals may also be more sensitive to their public image in Indonesia. For all these reasons, we might expect multinationals to be cleaner than their local counterparts.[7] Public plants in Indonesia are quite likely to be older, less efficient, and therefore more pollution intensive than their private counterparts. After these factors are accounted for, however, the residual effect of public ownership is not clear. We might expect lower pollution intensity for public plants operating under soft budget constraints, because they do not confront the full cost of abatement. However, national bureaucratic control may also shield state-owned facilities from local pressure.

2.3 The Quantity and Implicit Price of Pollution in Equilibrium

The following equations summarize environmental demand/supply relations under informal regulation, using the concept of equilibrium pollution in an implicit 'market for environmental services.' Expected signs of partial derivatives are noted with the variable definitions (? denotes uncertain impacts of opposing effects, as noted in the previous discussion).

Demand: The demand for environmental services from the firm is given by:

(1) $P_{ij} = f(W_{pij}, \; W_{Nj}, \; Q_i, \; A_i)$

where

	P_{ij}	= Total emissions from plant i in community j
-	W_{pij}	= Implicit pollution price for plant i
	W_{Nj}	= A vector of input prices in community j
-?		labor
?		energy
-		materials
+	Q_i	= Total output of plant i
	A_i	= A vector of plant characteristics
?		sector
+		age
-		factor productivity
-		multinational ownership
?		public ownership

Supply: The environmental supply schedule faced by the plant reflects the expected price it will pay for pollution at each level. This is modelled as:

[7] There is substantial anecdotal evidence to support this proposition. See for example Birdsall/Wheeler (1993). However, a study of abatement by pulping mills in four Southeast Asian countries by Hartman/Huq/Wheeler (1994) finds no effect of ownership after efficiency is accounted for.

(2) $W_{pij} = f(P_{ij},\ C_j,\ E_{ij},\ a_j,\ t_j)$

where

+	P_{ij} =	Total emissions from plant i in community j
	C_j =	A vector of community characteristics
+		income
+		post-primary education
?	E_{ij} =	Share of plant i in total manufacturing employment in community j. Measures a plant's economic attractiveness to the community (+), as well as its visibility (-).
?	a_j =	Urbanization proxied by population density. Measures plant visibility (-) as well as the size of the affected population (+).
+	t_j =	Total pollution load faced by community j

Two variables have opposing signs in (2) - E_{ij} and a_j. Plants which are big local employers may be more valued, but they are also more visible as polluters. Urbanized areas have larger affected populations, but the presence of many other factories also makes it more difficult to identify polluters.

We can solve for the firm's equilibrium pollution as:

(3) $P_{ij} = f(W_{lj},\ W_{ej},\ W_{mj},\ Q_i,\ s_i,\ v_i,\ f_i,\ m_i,\ g_i,\ n_i,\ y_j,\ a_j,\ t_j,\ e_j)$

Righthand variables for a regression equation are defined as follows, with expected signs of estimated parameters:

<u>Standard demand variables</u>

? W_{lj} = Manufacturing wage in community j

? W_{ej} = Energy price index in community j (Water +; Air -)

\- W_{mj} = Material input price index in community j

\+ Q_i = Total output of plant i [0 < elasticity < 1]

? s_i = Sector of plant i

<u>Firm-specific variables</u>

\+ v_i = Age of plant i

\- f_i = Factor productivity of plant i

\- m_i = Multinational status of plant i (1 if multinational)

? g_i = Public/private status of plant i (1 if public)

<u>Informal regulation variables</u>

? n_i = Share of plant i in community j's manufacturing employment

? a_j = Population density in community j

\- y_j = Per capita income in community j

\- t_j = Current total pollution load in community j

\- e_j = Post-primary schooling rate in community j

2.4 The Roles of Sector and Location

As previously mentioned, broadly-defined industry sectors differ greatly in average pollution intensity of production (see Hettige, et. al. (1994)). However, within-sector variation is also very great, and process-based variation can be large even within sectors defined at very high levels of disaggregation. Investors make simultaneous choices of products, processes, abatement levels and production location, taking relative prices at different locations into account. In general, we would expect pollution per unit of output to be relatively price-elastic.

2.4.1 Industrial location and pollution

Plants in areas with relatively high implicit pollution prices should have lower pollution per unit of output for two reasons. First, producers in sectors with high potential pollution intensity will tend to lower costs by locating elsewhere. Secondly, plants which have other reasons to locate in areas with high pollution prices will lower costs by reducing pollution. Thus, we would expect to observe disproportionately higher survival rates of plants which are old, inefficient and lower-abating in poorer, less literate areas where it is "cheaper to pollute".

The first factor explains why an appropriate plant-level pollution equation fitted to interregional data does not need to control for industry sector. Nevertheless, it is of interest to know how much variation in pollution-intensity is due to each of the two factors: Cross-sector location and within-sector abatement. This exercise will therefore estimate two regression models, with and without sector controls. The latter will permit an assessment of the impact of righthand variables on within-sector abatement.

2.4.2 Possible Endogeneity of Income and Education

Our model employs community mean income and education levels as exogenous variables. To see why this could be wrong, consider the basic contrast in Pigouvian and Coasian interpretations of the externality problem. The Pigouvian version assumes a static system of property rights in which damage from pollution is unidirectional: A factory locates in a community, and its pollution damages local health, economic activity and ecosystems. (Baumol, 1972). In contrast, a Coasian view assumes that the externality is reciprocal: When polluting factories locate in communities, the damaged parties have the option of moving away. Furthermore, other people who were formerly unaffected by the pollution may choose to move in as property values fall near the factory. To claim that the factory should bear the full cost of damaging their health would, of course, be specious. In either case, the basic policy prescription is clear: Both polluter and pollutee should bear some of the abatement cost when both are mobile (Hartman, 1982).

For policy, the relevance of the two perspectives seems context-specific. When a pulp mill locates upriver from a traditional community which has never experienced pollution, the Pigouvian perspective seems more appropriate. In an urban area where all agents are mobile, the Coasian approach has strong appeal.

For econometric analysis, context is also important. Within an urban region where residential mobility is comparable to factory mobility, an increase in polluting activity in some subregions will, by the previous reasoning, induce a decline in their average income and education. Thus, a model which relates pollution to residential income in one urban area is a good target for Granger tests of causality.

In our case, however, the argument for endogeneity is far less compelling. The units of analysis are kabupaten drawn from a broad spectrum of urban and rural areas in Java, Sumatra and Kalimantan. Indonesia exhibits great spatial variation in community cultures; the relative social and economic status of kabupaten has changed little since 1975. During that period, however, almost all of Indonesia's manufacturing has come into existence. Therefore, *in our case industrial location dynamics clearly dominate residential location dynamics*. If there is any bias in our estimates, we are confident that it is small.

2.5 Econometric Specification

We have no strong prior views on appropriate specification of the estimating equation for equilibrium pollution. The basic pollution demand equation [$P = f(W_p, W_n, Q)$] could be derived along with other input demand equations from a generalized cost function under the assumption of cost minimization. The full demand system could then be estimated using a translog or Box-Cox model. At present, however, this degree of rigor seems premature and inappropriate for several reasons.

First, our theory of informal regulation has not previously been tested. It would therefore seem better to start with a relatively simple and tractable empirical exercise. Furthermore W_p is endogenous and has many determinants. There are also many plant-specific demand-shift variables in the model. Our sample is not large, and we know that measurement errors for the lefthand variable, while probably normally distributed, are also quite large in some cases. Nonlinear estimation of a multi-equation input demand system simply seems too cumbersome to be worthwhile at this point. We therefore confine ourselves to estimation of log-log regressions, with dummies for categorical variables.

Heteroscedasticity across observations, often a problem with cross section analyses, was not a significant problem in our data. We have, however, reported White heteroscedasticity-consistent results. Although there is fairly significant correlation between different groups of variables in our dataset, multicollinearity does not appear to have been a problem for estimation.[8]

3. THE DATA

This study combines Indonesian manufacturing and socioeconomic census data with observations on plant-level water pollution measured as part of the Environment Ministry's PROKASIH (Clean Rivers) Program during the period 1989-1990. Our plant-level emissions data have been provided by BAPEDAL, Indonesia's National Pollution Control Agency in the Ministry of Environment. Data on plant characteristics and socioeconomic characteristics of communities have been provided by BPS (Indonesia's Central Statistics Bureau). At present, BAPEDAL and BPS do not assign common ID numbers to factories. Thus, creation of the combined dataset for plants' emissions and other characteristics required individual matching by name and location from separate files provided by BAPEDAL and BPS. Plant location information in the BPS file was in turn used to combine the plant-level data with socioeconomic variables for surrounding sub-provincial areas (kabupaten). In this section, we provide a more detailed discussion of data sources and quality.

3.1 The Measure of Water Pollution

For this study we focus on Biological Oxygen Demand (BOD), the most commonly-regulated water pollutant in both industrial and developing countries. Biological oxygen demand is associated with oxidation of organic water pollutants by naturally-occurring micro-organisms. This process removes dissolved oxygen from the water and can seriously damage some fish species which have adapted to the natural dissolved oxygen level. Organic water pollutants can also accelerate the growth of algae, which will crowd out other plant species. The eventual death and decomposition of the algae is another source of oxygen depletion as well as noxious smells and unsightly scum. The most common measure for BOD is the amount (kg) of oxygen used by micro-organisms to oxidize the organic waste in a standard sample of pollutant during a five-day period (hence the standard term '5-day BOD'). We have used the PROKASIH 5-day BOD measure to generate daily BOD load estimates.

PROKASIH itself was Indonesia's first nationwide program for industrial pollution control.[9] For this paper, we employ a cross-section of benchmark

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[8] Parameter signs and magnitudes were very stable across different model specifications, and variance inflation factors were not unreasonably high. Exclusion of single variables in correlated sets from regressions would, of course, increase the estimated effect of the remaining variables.

[9] We are analyzing its impact on pollution abatement in a forthcoming paper.

BOD measures taken at the beginning of PROKASIH. They reflect the environmental performance of Indonesian factories before the institution of nationwide formal regulation of any kind.[10] It was presumed that the initial BOD data would be subject to large stochastic reporting errors because of factory-level inexperience with appropriate sampling and measurement techniques. However, two large-sample tests of their validity by an outside consultant and the Environment Ministry show that they provide unbiased, robust estimates.[11] We expect the sampling errors to generate relatively high 'unexplainable' variance in the data set, but tests of significance should not otherwise be affected.

3.2 Plant Characteristics

Our data on plant characteristics are drawn from the Annual Census of Manufactures administered by BPS. This detailed census has been administered by BPS since 1975, and has been subjected to frequent and rigorous checks. It is generally considered to be one of the most reliable manufacturing datasets available for a developing country.

Standard census data have been used for our measures of total output value, age, and local employment share for the PROKASIH plants. The latter variable is constructed by calculating total kabupaten manufacturing employment from the census and dividing plant-level employment by this total. Because we do not have sufficient data for an estimate of total factor productivity, we have used reported value added per production employee as our proxy.[12] The census data also include information on the proportion of firm equity held by foreigners; the proportion of equity held by the regional and central governments, which we have combined to get a measure of public ownership; and sector identification - used to create the following ISIC[13]

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[10] Prior to PROKASIH, some local governments took measures against water pollution in response to crisis situations. Most notably, the Governor of East Java forced several large factories to install abatement equipment in 1987, when pollution of the Brantas River became extremely high during the dry season.

[11] The problem of bias is unusual in this context. Ordinarily, self-reported data on pollution would be suspected of downward bias. However, PROKASIH is a voluntary program with no formal sanctions for noncompliance with pollution reduction agreements. Plants which are committed to pollution reduction in a sanctionless program have an incentive to <u>over</u>estimate their pollution in the first period. In any case, the validity checks show that the PROKASIH estimates exhibit neither upward nor downward bias. See Afsah (1994) for a detailed discussion of estimation problems in the PROKASIH data.

[12] We calculated profits for each plant as [value added - total wage bill - interest (capital cost)] from the manufacturing census data for 1989. The correlation between value added per production employee and profit per production employee was positive and significant. Our variable may therefore be a reasonable proxy for productivity.

[13] ISIC refers to International Standard Industrial Classification codes.

sector dummies: food products (ISIC 3121), spinning and weaving textiles (3211), tanneries and leather finishing (3231), sawmills and wood mills (3311) and pulp, paper and paperboard (3411).

3.3 Input prices

For this study, we have been able to generate kabupaten-level price estimates for labor and energy. Materials price differences are proxied with a very crude locational dummy variable.

Kabupaten manufacturing wage: We have computed this from 1989 census data as the mean plant-level wage for production workers across all census plants (manufacturing plants employing more than 20 people) in the kabupaten. The plant-level estimates were obtained by dividing total wages and salaries paid to production employees by the total number of production employees.

Materials price: We have no direct measure of relative materials prices by sector. We use a Java location dummy to proxy transport cost considerations for heavy materials in pollution-intensive sectors. Higher prices at the factory gate should induce materials-saving and pollution reduction. Factories on Java now import much of their heavy materials from other islands, thus facing relatively higher transport-related costs. Higher materials costs should reduce materials- and pollution-intensity. A second, possibly important factor has to do with social and political power. In Indonesia, this still resides disproportionately in Java. Thus, Javanese kabupaten may collectively exert more influence on environmental performance than those on other islands.

Energy price: We have computed a single fuel price index for energy, using plant-level data from the 1989 manufacturing census. It is a weighted average of prices (per million BTU) for electricity, gasoline, high speed diesel oil(HSDO), diesel, kerosene, natural gas, coke and coal for each kabupaten. The weights are national energy expenditure shares for each fuel.[14]

3.4 Community Characteristics

Our estimates for per capita expenditure, post-primary education and population density are drawn from the SUSENAS surveys conducted by BPS in 1988 and 1990. Per capita household expenditure was judged to be the most reliable

[14] Using 1989 manufacturing census data, we have separately computed prices for electricity and a fossil fuel index for each kabupaten. This index is a national purchase-share-weighted average of prices (per million BTU) for gasoline, HSDO, diesel, kerosene, natural gas, coke and coal. Since the two kabupaten indices turned out to be highly correlated, we decided to use a single fuel price index.

available measure of living standards, and was used to proxy per capita income.

3.5 Data Description

Out of a total sample of 253 plants, we have exact ownership information on 246 plants: of these 3 are wholly foreign-owned and over 50 have some foreign participation; 13 are completely owned by the government and 178 are private domestic firms. Factory age ranges from 0 years (2 firms) to 90 years (2 firms), with the median age of firms being 10 years. The geographic spread of the data is restricted to three islands - Java (189 firms), Sumatra (40 firms), and Kalimantan (24 firms) - and 8 provinces. Forty one ISIC codes or sectors are represented in the dataset and firms range in size from 22 to 41,821 employees, with share in kabupaten employment varying from 0.02% to 91%. The kabupaten represented in the data are quite varied as well: 1990 population density ranges from 3.4 to 53,876 persons per square km., the proportion of the population with more than a primary education varies between 6.85% and 48.5%, and mean annual per capita expenditure varies from Rp. 256,447 to Rp. 837,277 (1990 Rp.).

Mean per capita expenditure, population density (the urbanization proxy), and the proportion of the kabupaten with more than a primary education are significantly positively correlated in the raw data. As expected, the locational dummy for Java is positively correlated with mean per capita expenditure and population density but negatively associated with the proportion of the population with higher than primary schooling. Mean manufacturing wage in the kabupaten is positively related to the average fuel price in the kabupaten.

4. RESULTS

Table 1 presents the results for pollution regressions estimated with and without sector controls. They are strongly consistent with our basic thesis: Without any formal regulation, equilibrium emissions can still vary strongly across firms and regions in response to differences in scale, regional input prices, firm characteristics, and the degree of informal regulation by local communities. Parameter signs and standard error estimates are mostly stable across Models I and II.

The observed pollution intensity of production at a particular plant is the outcome of several decisions: the choice of location, product, process technology and end-of-pipe abatement. Model I depicts the end result of all these choices. Locational and investment decisions (the choice of sector, site, and technology) respond to relative prices, including that of pollution - across space, sectors, and prodution processes. The degree of end-of-pipe abatement is also a response to pollution and other input prices at the production site. As previously noted, sector dummies in Model II separate the effects of these decisions by controlling for prior choice of location at the sectoral level. Model II depicts the within-sector factors that influence abatement - and thus emissions. Predictably, the use of sector controls reduces estimated elasticities for the five locational variables: wages, fuel prices, population density, post-primary education and per capita income (although the latter remains highly significant in either model). It is clear that significant variation in the observed level of pollution emissions is explained by the choice of technology and sector. Although we present the results of both model specifications in Table 1, our interpretation of the results is based on Model I since it incorporates both the locational and the abatement response. One-tail tests would be appropriate for tests of significance for most parameters (exceptions are energy price, firm employment share and population density, whose net effects could be either negative or positive). However, Table 1 applies two-tail tests to provide the most conservative measures.

4.1 Standard Demand Variables

As expected, the estimated output elasticity of water pollution is significantly less than one: Pollution intensity declines with scale. Specifically, the pollution intensity of production decreases by 0.35% for each percent increase in output. The wage results suggests complementarity of labor and water pollution. However, the high estimated wage elasticity has a high standard error, so we could not reject hypotheses of zero or positive elasticities at any elevated confidence level.[15] Part of this result undoubtedly reflects straight substitution effects. Higher wages may also reflect higher levels of technical skills on the part of the local workforce, which might lead to "within" firm efforts to produce more efficiently and cleanly.[16] Model II suggests that much of the wage effect comes through location, not local abatement.

Estimated energy price elasticities are negative and large, but standard errors are again so high that we cannot reject hypotheses of zero or positive elasticity at any elevated confidence level. The effect of location on Java is as expected: Large, negative and highly significant. As previously noted, we have used this as a crude proxy for relative materials prices. There may also be some reflection of political power here, although we have introduced separate controls for community income and education.

[15] Spatial autocorrelation is a possible explanation for the low levels of significance of some variables. However, the fact that the data cover plants along different rivers in widely separated regions makes us discount this possibility.

[16] We are indebted to Mainul Huq for this point.

TABLE 1: REGRESSION RESULTS
Dependent variable: Log BOD load

N=250	Model I [Adj R^2=0.3146]		Model II [Adj R^2=0.3805]	
Variable	Coefficient Estimate[b]	t stat.	Coefficient Estimate[b]	t stat.
INTERCEPT	31.580 (6.76)	4.67**	17.479 (7.32)	2.39**
DEMAND VARIABLES				
Log [OUTPUT]	0.647 (0.19)	3.34**	0.712 (0.19)	3.78**
Log [WAGE]	-0.740 (0.62)	-1.20	-0.316 (0.61)	-0.52
Log [FUEL PRICE]	-2.257 (2.42)	-0.93	-1.267 (2.44)	-0.52
D[JAVA]	-1.231 (0.55)	-2.23*	-1.530 (0.51)	-2.98**
FIRM VARIABLES				
Log [VA/WORKER]	-0.325 (0.18)	-1.81*	-0.312 (0.17)	-1.79*
Log [AGE]	0.273 (0.17)	1.64	0.179 (0.17)	1.07
FOREIGN-OWNERSHIP	-0.002 (0.01)	-0.27	0.0004 (0.01)	0.06
STATE OWNERSHIP	0.017 (0.01)	2.64**	0.021 (0.01)	2.91**
INFORMAL REGULATION				
Log [LOCAL EMPL.	-0.352 (0.18)	-1.94*	-0.313 (0.17)	-1.84*
Log [INCOME PER	-4.021 (0.91)	-4.41**	-2.811 (0.93)	-3.02**
Log [% GT PRIMARY]	-1.072 (0.57)	-1.87*	-0.668 (0.57)	-1.17
Log [POP. DENSITY]	0.344 (0.17)	2.04*	0.128 (0.21)	0.62
D [TEXTILES]			1.247 (0.37)	3.41**
D [LEATHER TANNING]			1.961 (0.63)	3.12**
D [FOOD]			2.480 (0.55)	4.52**
D [PULP, PAPER]			2.265 (0.57)	3.98**
D [WOOD PRODUCTS]			-0.930 (0.92)	-1.02

[b] White heteroscedasticity consistent standard errors in parentheses

* $H_0: \beta = 0$ rejected with 90% confidence (two-tail)
** $H_0: \beta = 0$ rejected with 99% confidence (two-tail)

4.2 Firm-Specific Factors

Our results suggest that firm and plant characteristics have a strong impact on pollution intensity. More efficient plants are cleaner, as hypothesized; older plants are dirtier, but the latter effect is neither as large nor as significant as we would have supposed a priori. Pollution intensity changes by about .3% in response to each 1% change in efficiency. After controlling for scale, age and efficiency, foreign participation doesn't appear to have a significant effect on pollution intensity. This confounds the prior hypothesis, and suggests strongly that the anecdotal evidence has failed to distinguish foreign ownership from plant characteristics.

Such factors are, in fact, significantly associated with variations in ownership. We have studied these relationships using the proportion of equity held by foreigners as well as the proportion of firm equity held by the government in a separate analysis based on the entire 1989 Census of Manufactures.[17] The results were confirmatory in some ways, and surprising in others. Plants owned by firms with greater equity held by foreigners <u>OR</u> the government are older, bigger, higher in value added per worker, and higher in share of kabupaten manufacturing employment. Three out of four characteristics are negatively associated with pollution intensity in the regression results. The residual effects (measured by the parameters for public and foreign ownership shares) are neutral for foreign status and significantly positive for public enterprises.

Thus, anecdotes about 'clean' multinationals may well have confused 'outsider' status with the effects of size and efficiency. Our results suggest that big, efficient domestic firms are not significantly more pollution-intensive than their multinational counterparts. Public enterprises, on the other hand, present a mixed picture. Their characteristics (except age) imply relatively clean operation, but the pure 'public' effect is extremely dirty. Thus, the posited 'shielding' effect seems to outweigh any leverage from soft budgets.

4.3 Informal Regulation Variables

Our results for community income and education are strongly consistent with the informal regulation hypothesis. The estimated income elasticity of pollution reduction is highly significant and extremely large: Pollution intensity declines 4% with each 1% increase in community income. Given a threefold range in sample community incomes, this implies a major impact. Income and education are obviously related: the sample correlation is 0.67. Nevertheless, education has a separate and significant impact in Model I:

---

[17] We used the following regression: $\ln Y = a_0 + a_1 F + a_2 P$, where Y represents the various dimensions of interest (vintage, scale of output etc.), F refers to the proportion of equity held by foreigners and P to the proportion owned by the state and central government.

Pollution intensity declines 1% with each 1% increase in community share of residents with greater than primary education. Given the sevenfold range of variation in the sample, the results also suggest a major, separate impact for community education.

The results for plants' local employment share and population density reflect the net impact of two forces. Plants which are bigger local employers might get laxer treatment on pollution, and more populous areas will have more people affected by pollution. These considerations would imply a positive impact on pollution for employment status and a negative impact for population density.[18] On the other hand, bigger plants attract more attention, and pollution from plants in crowded urban areas is harder to trace to the source.[19] These 'visibility' considerations would imply a negative impact on pollution for employment status and a positive impact for population density.

In this case, the visibility effect seems clearly dominant. Both results are consistent with the second interpretation above: Plants with higher local employment shares have lower pollution intensities, ceteris paribus; plants in more densely-populated areas are more pollution intensive.

4.4 Summary Assessment of the Results

To summarize our results, plant-level water pollution intensity (BOD load per unit value of output) is significantly lower in firms which are larger, more efficient, higher in local employment share, and confronted with higher local wages and materials costs. Pollution intensity is higher in older, publicly-owned firms. It is also higher in kabupaten which are more urbanized, poorer and less-educated.

What has been the relative impact of these variables on the environmental performance of Indonesian factories in the absence of formal regulation? We can answer this question by simulating the comparative impact of key firm and community characteristics. From the sample, we have determined first and third quartile values for factory age; factory value-added per worker; community per capita income; and community proportion with greater than primary education. Holding other regression variables at their mean values, we then calculate pollution intensities along three dimensions: plant age/efficiency [75th percentile plant age and value added per worker vs. 25th percentile values]; ownership [foreign participation; public participation; private domestic]; and informal regulation [75th percentile community income and education vs. 25th percentile values]. The results, displayed graphically in Figure 1, show striking differences:

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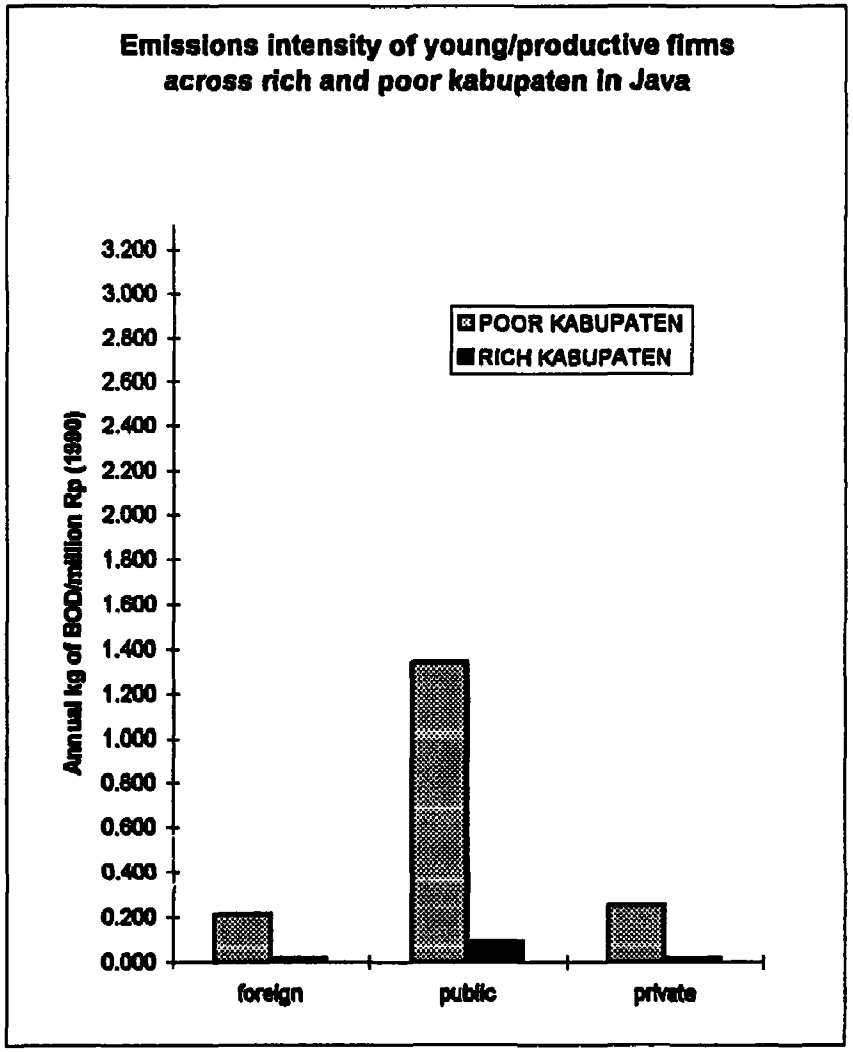
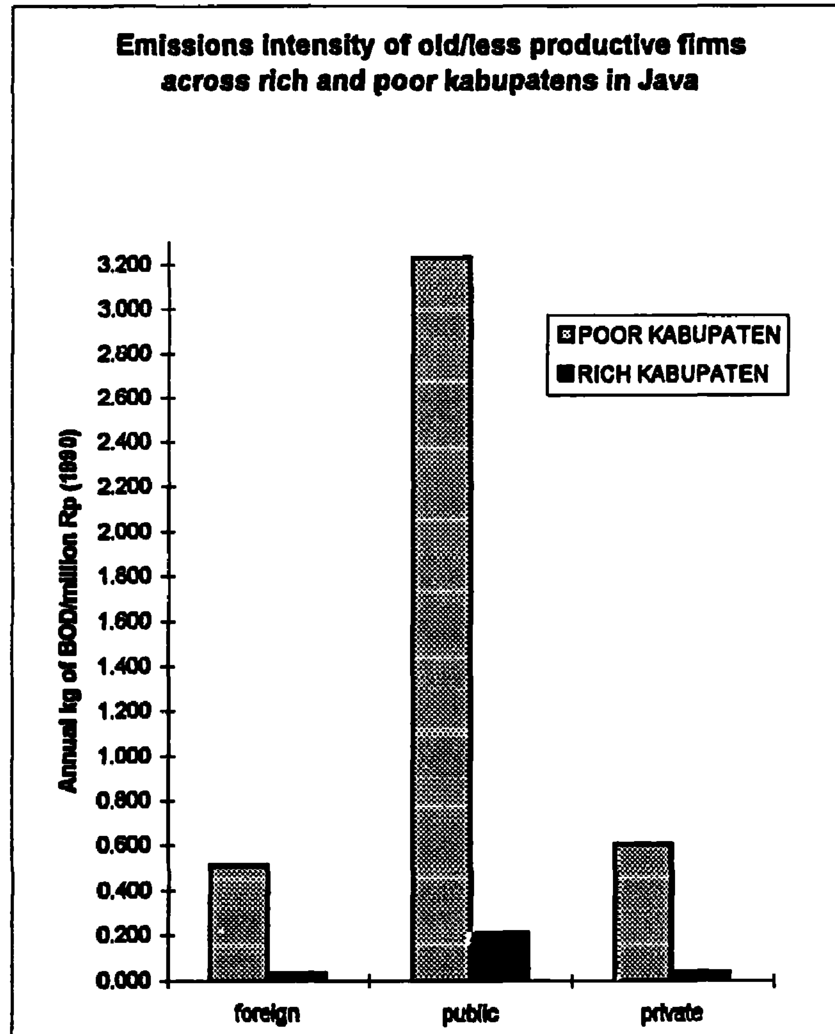
[18] We should note that the employment effect is reciprocal: a large plant will be very dependent on the community for employees, and this may mitigate its bargaining power.

[19] For supporting survey evidence see Huq/Wheeler (1992) and Hartman/Huq/Wheeler (1994).

Figure 1



Emissions intensity of young/productive firms
across rich and poor kabupaten in Java
Annual kg of BOD/million Rp (1990)
3.200
3.000
2.800
2.600
2.400
2.200
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
POOR KABUPATEN
RICH KABUPATEN
foreign
public
private



Emissions intensity of old/less productive firms
across rich and poor kabupatens in Java
Annual kg of BOD/million Rp (1990)
3.200
3.000
2.800
2.600
2.400
2.200
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
POOR KABUPATEN
RICH KABUPATEN
foreign
public
private

- **Plant characteristics:** An old, unproductive plant (75th percentile on age; 25th percentile on value added per worker) **is about 2.4 times more water pollution intensive** than a young and productive firm (25th percentile on age; 75th percentile on value added per worker).
- **Ownership: Public enterprises are about 5.4 times more water pollution intensive** than plants owned by private domestic firms. The results suggest that multinationals are somewhat less pollution-intensive than private domestic firms, but all estimates fail to pass reasonable significance tests.
- **Informal regulation: Plants in poor, less educated areas** (25th percentile on income and education) **are about 15.4 times more water pollution intensive** than plants in relatively affluent, well-educated (75th percentile) areas.

5. SUMMARY AND IMPLICATIONS

Econometric work on determinants of pollution intensity at the plant level is scarce even in the OECD economies. As far as we know, this is the first such study for a developing country. Our results suggest that, even in the absence of any formal regulation, factory-level water pollution intensity in Indonesia has been highly responsive to many variables which can be affected by non-environmental policies.

5.1 Future Pollution Without Formal Regulation

For several major determinants of pollution intensity, recent trends in Indonesia are extremely hopeful. To begin with a simple but powerful consideration, there will be no more 'old' factories. Our results indicate that new facilities are cleaner than average existing plants. Similarly, there are not likely to be any new state enterprises in the industrial sector. Deregulation and enhanced competition during the 1980's have also presumably increased plant-level efficiency in the private sector. Post-primary education, industrial wages and per capita income are advancing steadily throughout Indonesia.

If cross-section results can be extrapolated to time series, these trends should be associated with an extremely large drop in the average pollution intensity of Indonesian manufacturing, no matter what happens in the formal regulatory sector. Furthermore, the predicted effect does not depend on any increased presence of foreign, putatively 'green,' firms in Indonesia. More multinationals will certainly come, but our evidence suggests that their environmental performance will be matched by domestic firms which are otherwise-comparable.

Of course, the basic question remains: Can we credibly extrapolate from the cross-section results? We see no problem for changes in plants' age, efficiency and ownership. However, the extremely powerful cross-section result for kabupaten income and education may seem suspect. As previously noted, we are not particularly worried about estimation bias from joint determination in pollution intensity and income/education levels. Indonesian manufacturing has emerged very quickly, while cross-kabupaten socioeconomic rankings have been relatively stable.[20]

However, the problem of 'sorting' must still be considered. Suppose that all plants have fixed pollution intensity and locate so as to minimize total expected costs. Then 'dirty' plants will move to poor communities which cannot effectively resist; clean plants will locate in rich communities. Income growth in poor communities will not change this 'sorting' as long as the distribution of income doesn't change significantly.[21] Rich communities will still have higher preference for environmental quality and more power to enforce their preferences.

If 'sorting' were the dominant factor, we would have to be much less sanguine about the potential impact of changes in income and education on pollution intensity. However, as we have previously noted, pollution in all industry sectors is highly elastic to choices of products, processes, materials use rates and end-of-pipe abatement. In our view, the result is therefore explained more by adjustment than sorting. However, a more definitive answer will only be possible once we have appropriate time series data.

5.2 Preferences or Power?

Our results suggest that pollution intensity is much greater in poor communities because of disparities in preferences and power. How much is attributable to each? We can draw some suggestive evidence from the distribution of pollution intensities in poor areas. Low-income communities with relatively low pollution intensities may well have greater leverage because they have cohesive ethnic or religious groups, particularly gifted community leaders, national NGO chapters, etc. These outlier communities have more power, but their income-based preferences should be similar to those of other poor communities.

We explore the potential importance of power by examining the intensity variation of communities in the poorest quintile vs. the variation in mean intensity between the poorest and richest quintiles. We control for firm characteristics and 'visibility' factors in a preliminary regression.

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[20] Casual empiricism suggests that in Indonesia the wealthy do not move; the movement of the poor is towards jobs in urban/industrial areas, leaving behind the relatively poorer agricultural hinterland. This would tend to attenuate the observed disparity in pollution intensity across rich and poor areas. Likewise, differential location of polluting firms in poorer areas would again reflect the power of the rich to translate their preferences into desired environmental quality.

[21] We are indebted to Martin Ravallion for this point.

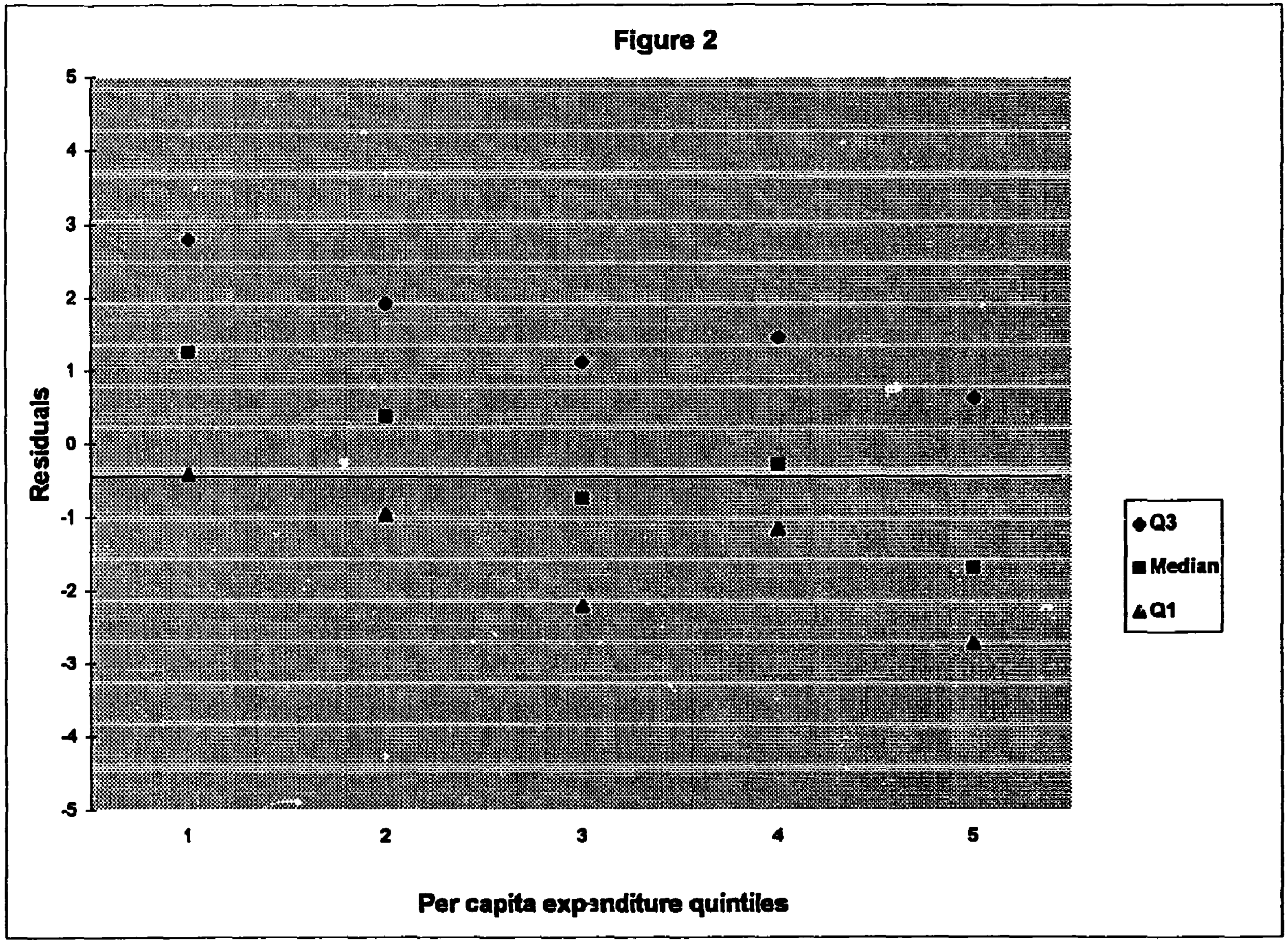
Figure 2
5
4
3
2
1
0
-1
-2
-3
-4
-5
Residuals
1
2
3
4
5
Per capita expenditure quintiles
Q3
Median
Q1

Residuals are then sorted by income quintile; medians and quartiles are displayed by community income group in Figure 2. The result suggests a strong role for power; the difference between the first and third quartiles for poor communities is larger than the difference between medians for the poorest and richest communities. The "best off" poor communities appear to be much better off than the "worst off" rich communities. It seems reasonable to infer that the estimated income elasticity of -4 in Model I reflects a sizable measure of power as well as preferences. If this is true, the national regulatory agency could play a useful equalizing role.

5.3 Formal vs. Informal Regulation

How does the informal pollution equilibrium in Indonesia compare with probable conditions under formal regulation? A formal system might well have the edge in priority-setting, monitoring and enforcement. National regulatory agencies generally have technical staff members who can do scientific risk assessment. They can impose uniform reporting requirements on factories and use national government power to enforce the rules. However, national agencies have revealed a strong bias toward uniform standard-setting, even in countries with great variations in geography and levels of industry concentration. In addition, new regulatory institutions in many developing countries are still quite weak in technical risk assessment, data collection and consistent enforcement.

The strengths and weaknesses of informal regulation present an interesting contrast. As we have noted, poor communities may have few avenues of self-defense. In addition, our results are consistent with the 'visibility' hypothesis: Knowing little about long-term risks, local communities will tend to focus on visible pollution whose impact is immediate and obvious. Monitoring may focus on plants which are easy to observe rather than those which should be observed. Our results on population density suggest such a problem: Plants which are hidden in large, polluted complexes may face less monitoring than plants in rural areas with few pollution problems.

However, informal regulation also has clear advantages over rigid formal systems. Local communities often have a different perception of regulatory benefits and costs than national agencies. They may also have a more accurate sense of local pollution problems than new agencies whose monitoring capabilities are weak. Thus, informal regulation may yield a pattern of local environmental shadow prices superior to the pattern realistically achievable under formal regulation.

Since each system has clear advantages and disadvantages, we strongly suspect that the optimal system would be a hybrid one. In such a system, the national agency might concentrate its resources on monitoring, inspection, risk analysis and dissemination of information to local communities. Local communities could be empowered to set their own standards, using the national agency for legal support and enforcement where necessary.

Given the preliminary nature of this work, it would be premature to push these ideas too forcefully. Nevertheless, our results are consistent with the existence of a strong informal regulatory system in Indonesia. If that is the case, Indonesia may well want to incorporate the best features of this system into national regulatory policy.

6. REFERENCES

Afsah, S., 1994, An Evaluation of Indonesia's PROKASIH 'Clean Rivers' Program, (Washington: World Bank, PRDEI)

Baumol, W., 1972, 'On Taxation and the Control of Externalities," American Economic Review, 62, pp. 307-322

Birdsall, N. and D. Wheeler, 1993, "Trade Policy and Industrial Pollution in Latin America: Where Are the Pollution Havens?", 1993, Journal of Environment and Development, 2,1, Winter

Christensen, L., D. Jorgensen and L. Lau, 1973, "Transcendental Logarithmic Production Frontiers," Review of Economics and Statistics, 55, pp. 28-45

Hartman, R., 1982, "A Note on Externalities and the Placement of Property Rights: An Alternative Formulation to the Standard Pigouvian Results," International Review of Law and Economics, 2, pp. 111-118

Hartman, R., M. Huq and D. Wheeler, 1994, Pollution Abatement in Developing Countries: A Coasian Interpretation (Washington: World Bank, PRDEI)

Hettige, M., P. Martin, M. Singh and D. Wheeler, 1994, IPPS: The Industrial Pollution Projection System, (Washington: World Bank, PRDEI)

Huq, M. and D. Wheeler, 1992, Pollution Reduction Without Formal Regulation: Evidence from Bangladesh, (Washington: World Bank, PRDEI)

Tietenberg, T., 1992, Environmental and Natural Resource Economics. New York: Harper Collins Publishers Inc.

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